Noise Exposure to Artisanal and Small-scale Gold Mines in Western and Nyanza Regions in Kenya

Charles Buyela, Paul Njogu, Gideon Kikuvi, Joseph Kamau and Charles Mburu

Abstract - Artisanal and small-scale gold mining (ASSGM) has experienced rapid growth due to the mineral's value in western and Nyanza regions of Kenya. Poverty levels have also forced the people to engage in mining activities as a source of income. Artisanal mining carries hazardous risks from machinery and tools used for blasting, crushing and milling processes of rocks. The aim of this study was to investigate the levels of exposure to occupational noise in artisanal and small-scale gold mines in Western and Nyanza Regions of Kenya. A sample two hundred and sixty (260) miners and non-miners was selected for the study. The non-miners acted as the control and were selected from same geological location but away from artisanal mining activities. The study adopted purposive sampling technique for selecting sites and a walk-through survey to identify noise emitting sources and processes. Exposure to noise levels was measured using an Integrating sound level meter (LA220) and Global Positioning Systems (GPS-GARMIN model) used to find the exact location of sites. Results indicated that there was high exposure to noise which ranged from 72±9.9 to 113.5±9.9 dB (A); with time weighted average for 8-hrs of 92.8±20.8 dB (A) whereas the control site ranged from 42.0± 2.8 to 73.2± 2.8 dB (A) with time weighted average for 8-hrs of 58.32± 9.5 dB (A). The average noise levels above acceptable limits of 90dB (A) were recorded as follows; Rosterman (13%), Ikolomani (18%), Masara (21%) and Francis (16%) whereas noise levels within acceptable limits were recorded in control areas being below the limit set. In conclusion, the mining community is at a high risk of exposure to high levels of occupational noise. Study recommends that the mine owners/county government to give priority to developing hearing conservation guidelines to miners. The central government should also come up with guidelines on occupational safety and health in artisanal gold mining to facilitate compliance with OSHA act requirements in the sector and offer effective participative training.

Key words: Artisanal and small-scale gold mining, Occupation Noise, mining safety, miner's health

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I. INTRODUCTION

Occupational noise is defined as sound that is a nuisance or intolerable [1]. It can also be defined as sound that has potential for inflicting hearing impairment or other adverse physiological and psychological change in the body [2]. Often, the main sources of noise in our residential environment are transport; occupational and neighboring/community noise. Transport noise emanates from motor vehicle, trains and aircrafts. Occupational noise comes from industrial machines or working tools; Neighboring/community noise comes from surrounding environment [2]. Likewise, artisanal and small-scale gold mining (ASSGM) is defined as mining by individuals, groups or cooperatives with minimal or no mechanization often in the informal sector [3]. This is an important economic activity in many developing countries across Africa, Asia and South America. It is estimated that 13 million people globally depend on artisanal gold mining for their livelihood and majority of these people are in developing countries [4]. For example, there are several gold deposits in various parts of Kenya including; Migori (Suna west and Suna East) and Kakamega (Rosterman and Ikolomani- Liranda corridor) [5]. The small-scale miners employ traditional techniques for mineral extraction and thus they operate under hazardous, labor intensive, highly disorganized and illegal conditions [6]. Many tasks carried out within the (ASSGM) work process such as extraction, crushing and milling are associated with elevated occupational and community noise, often to levels that exceed WHO guideline limits for the prevention of hearing loss [7]. Machinery or tools used are noise- emitting sources at artisanal gold mining sites [8]. Continuous, Intermittent and impulsive type of noise is common in (ASSGM) sector [9]. Miners communicate among coworkers by shouting at arm-length position as an indicator for hearing induced impairment challenge [6]. Noise exposure is associated with the following health outcomes: hearing impairment, hypertension, sleep disturbance and cognitive impairment as well as social and behavioral effects including annoyance [10]. Hence, there is need to assess Noise Exposure to Artisanal and Small-scale Gold Miners in Western and Nyanza Regions in Kenya

II. MATERIALS AND METHODS

A. Study Area

The study was conducted in Suna West and Suna East,

Migori County in Nyanza and Roster man and Liranda corridor-Ikolomani, Kakamega County in Western Kenya, which have major gold deposits (Figure 1).

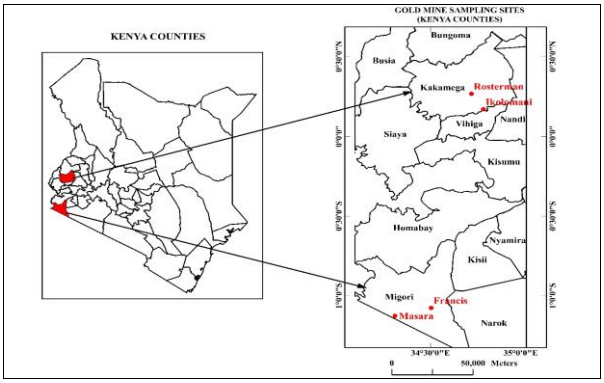

Figure 1: Nyanza- Migori and Western - Kakamega Liranda corridor-Ikolomani

B. Study Design and Sampling

Descriptive cross -sectional design that involved purposive sampling technique was applied in selecting the study sites and machines/tools present in gold mining.

a) Noise Threshold Limit Values (TLV)

The recommended noise limits to reduce hearing loss (occupational deafness) is set at 90 dB (A) for 8 hours daily exposure by International Labour Organization (ILO) and World Health Organization (WHO) as the occupational exposure level (OEL), which most workers can continually be exposed to noise without developing occupational hearing loss in industries. The International Standards Organization (ISO), requires that the time spent in a noise environment to be halved for each 3 dB rise in the noise level above the set limit, for example, for 8 hours the set limit is 90 dB (A), 93 dB(A) 4 hours, 96 dB (A) 2 hours and 115 dB (A) less than 2 minutes. For workshop and plant area where occasional communication is required, the recommended limit is 75 dB (A). In offices where the nature of work requires higher mental concentration, the accepted noise level is below 60 dB (A). For workshop office, control room, laboratories and workshop where easy communication is required, the recommended limit is 55 dB (A). For offices, mess-room, canteens, the limits recommended is 50 dB (A).

b) Noise acceptability

The difference between the ambient noise level and the noise levels measured at 1 to 2 M from the noise-emitting source determines the acceptability of the noise at a workstation and the difference provides an indicator of the likelihood of complaints. Where the difference is +10 dB or more, the complaints are likely but when the difference is less than 10 dB, the complaints are not likely.

c) Data collection and Analysis

The study included a walk-through at mining sites to directly observe the working conditions, work processes and workers' practices, and to identify OSH hazards (noise emitting sources) that cannot be quantified or measured. Checklists and observation were used to assess the location, process, environment, structure and related factors (hazards) at the workplace. On the other hand, quantitative data were collected through actual measurements of the physical hazards (noise levels). Integrating sound level meter (LA-220) was set at an average hearing height of a worker and 1-2 M from the Machines and tools i.e. noise emitting start-point source facing against wind direction. At each site, measurement was taken between 08:30 hrs,12.30hrs and 17:30 hrs. local time, for five non-consecutive weekdays. Measurements were recorded using direct reading from Integrating sound level meter (ISLM) at arm's length position against the wind at the average height of the ear of a worker and Global Positioning Systems (GARMIN model) was used to determine the exact location of sites to be assessed. The data collected from the mining sites was then compared with similar data collected away from mining activities and against accepted noise exposure levels based on (OSHA, 2007). Data was analyzed using means, standard deviations, chi square tests and presented in charts and tables at 0.05 significance level.

III. RESULTS AND DISCUSSION

Study sites presented higher mean values of noise levels as compared to control sites; Rosterman (86.88±10.68), Ikolomani (86.0±10.66), Masara (96.97±9.21), Francis (89.38±11.86), & control (58.32±9.53) Figure 2).

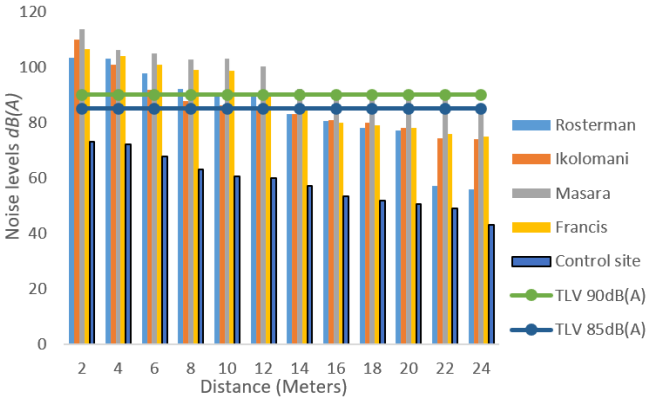

Figure 2: Noise levels at four artisanal gold mining sites

Exposure to physical hazards (noise) was also identified from workplace environment and equipment/tools used to perform certain specialized tasks in the research institutions (KALRO) [11]. The study findings agree with the findings that employees working in the generator department in manufacturing sectors, Thika are exposed to noise with average continuous equivalent noise being 92.2±1.6dB(A) that significantly exceeded the exposure limit of 90dB(A) by the Kenyan law(Legal notice no. 25) places peak noise level at 114.2±0.5dB(A). [12].

In table 1, the coefficient of variation (cv) indicates the size of a standard deviation in relation to its mean. The cv was observed to decrease more slowly as the peaks/ noise

intensity became stronger at mining sites by 9% to 13% as compared with control sites-16%. Equal coefficient of variation indicates equal propagation/ spreading of noise at artisanal gold mining sites. Coefficient variation at sites indicate reproducibility of noise peak waves. (Table 1).

Table 1: Mean, standard deviation and correlation values of noise exposure levels at sites in (dB(A))

SITES	Rosterman	Ikolomani	Masara	Francis	Control site
Mean dB(A)	86.88	86.01	96.97	89.38	58.32
Se (Mean)	3.084299	3.076437	2.657874	3.424042	2.75001
Std. Dev	10.68	10.66	9.21	11.86	9.53
Min	72.00	74.00	84.00	75.00	42.00
Max	103.20	110.00	113.60	106.50	73.20
CV	0.12 (12%)	0.12 (12%)	0.09 (9%)	0.13 (13%)	0.16 (16%)

Miners and non-miners are likely to be exposed to hazardous noise from machines and tools involved in artisanal processing of gold of percent coefficient of variation from (0-13) %. Time weighted average for 8-hrs being 92.8±20.8. The measured noise levels that ranged from 72.0 to 113.6 dB (A), (Figures 3 and 4).

C. Noise propagation

At gold mining sites, there is geometric spreading of noise because of the expansion of the wave front from noise emitting Machines and tools. It is a spherical spreading of noise with distance in meters as presented in figure 3

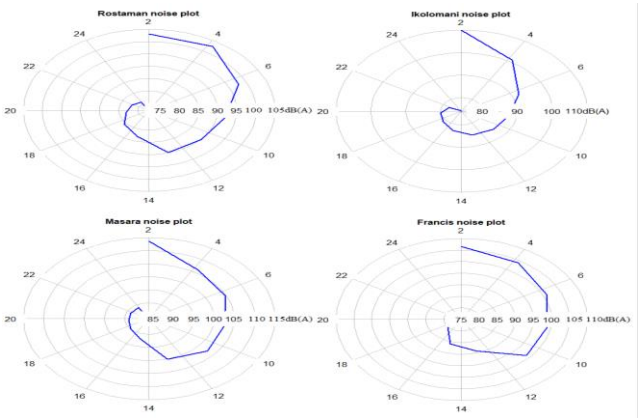

Figure 3: Distance from noise emitting machines in relation to exposure

From Table 2, there was no significant differences in Noise Levels at the four mining sites i.e. (Rosterman, Ikolomani. Masara and Francis) ($\chi 2$ =132; df=121;p>0.05,$\chi 2$=132; df=121;p>0.05 $\chi 2$ =120; df=110;p>0.05 $\chi 2$ =132; df=121;p>0.05 respectively (Table 2).

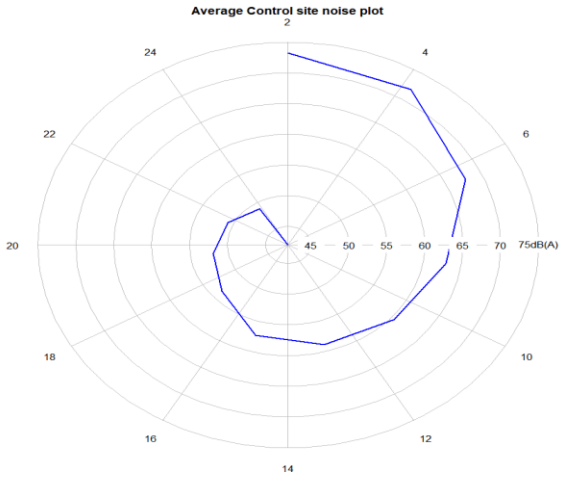

Figure 4: Distance from noise emitting machines in relation to exposure

Table 2: Comparison of the noise levels in the four artisanal gold mining site with control site

Chi-Square Tests			
	Pearson Chi-Square Value	Df	Asymptotic Significance (2-sided)
Rosterman and control	132	121	0.2329
Ikolomani and control	132	121	0.2329
Masara and control	120	110	0.2421
Francis and control	132	121	0.2329

Initiating hearing conservation program is required at action level (Exposure equal or above limits of 85 dB(A)) per artisanal mining sites in order to eliminate or reduce exposures to hazardous noise [13].

The research revealed that majority of miners do not often use personal protective equipment (PPEs) with only 10% of study population agreeing that lack of miners protective gears, poor mining technology, and unsafe sexual intercourse have resulted to gold mining health and safety problems [14]

IV. CONCLUSIONS AND RECOMMENDATIONS

This study found that (ASSGM) workers are exposed to Occupational noise level of 92.8±20.8 that is significantly above the set limits with time weighted average of 8-hrs. The measured noise levels that ranged from 72.0 to 113.8 dB (A), can easily bring about noise induced hearing loss to miners if there is no hearing protective equipment used and safe work procedure followed.

There is need for training and certification program on occupational safety to ensure workers in this set up understand the risks they are exposed to and the possible preventive measures. Furthermore, this study recommends audiometric testing of miners and to investigating relationship between OSH awareness and noise preventive strategies.

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